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Distribution of *Anastrepha* Schiner, 1868 (Diptera, Tephritidae) in Brazil: new records from the state of Paraná

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Abstract

The first records of six *Anastrepha* species are reported for the state of Paraná, Brazil, namely *A. amita* Zucchi, 1979; *A. barnesi* Aldrich, 1925; *A. consobrina* (Loew, 1873); *A. manihoti* Lima, 1934; *A. morvasi* Uramoto & Zucchi, 1999; and *A. punctata* Hendel, 1914. *Citharexylum solanaceum* Cham. (Verbenaceae) is recorded as a new host plant for *A. amita*, and *Inga vera* Willd. (Fabaceae) as new host plant for *A. distincta.* With these new records the number of species of *Anastrepha* recorded from Paraná is increased from 15 to 21.

Keywords

Diversity, fruit flies, geographic distribution, hosts, traps, Trypetinae.

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Introduction

Anastrepha Schiner, 1868 is the largest and most economically important genus of Tephritidae in the Americas (Norrbom 2010), comprising more than 300 described species (Norrbom et al. 1999; Norrbom and Korytkowski 2009, 2011, 2012; Norrbom et al. 2012, 2015, 2018; Mengual et al. 2017).

This genus can usually be distinguished from other Tephritidae by the strongly curved M-vein apex anteriorly. The wings have a typical pattern including C-, S-, and V-bands brown or yellowish, sometimes fused or reduced; some species mimic wasps and have a complete costal band (Foote 1980; Norrbom 2010).

In Brazil, 121 species are recorded, and the genus is present throughout the country (Zucchi and Moraes 2008). In Paraná state, 15 species have been recorded: *Anastrepha barbiellinii* Lima, 1938; *A. daciformis* Bezzi, 1909; *A. dissimilis* Stone, 1942; *A. distincta* Greene, 1934; *A. elegans* Blanchard, 1937; *A. fraterculus* (Wiedemann, 1830); *A. grandis* (Macquart, 1846); *A. montei* Lima, 1934; *A. obliqua* (Macquart, 1835); *A. pickeli* Lima, 1934; *A. pseudoparallela* (Loew, 1873); *A. serpentina* (Wiedemann, 1830); *A. simulans* Zucchi, 1979, *A. sororcula* Zucchi, 1979; and *A. xanthochaeta* Hendel, 1914 (Garcia 2003; Zucchi and Moraes 2008; Norrbom and Korytkowski 2009; Husch et al. 2012; Monteiro et al. 2019). However, few studies specifically focused on *Anastrepha* have been conducted in Paraná, and the diversity of species in the state is poorly known (Fehn

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1981; Albuquerque et al. 2002; Garcia 2003; Zucchi 2007; Husch et al. 2012; Monteiro et al. 2019).

Here, we report the first records of six *Anastrepha* species from Paraná, and a new host plant record for *Anastrepha amita* Zucchi.

Methods

Specimens were collected over six years (2013–2018) in undisturbed areas of Atlantic Forest (Mixed Ombrophilous Forest and Semi-deciduous Seasonal Forest) from Paraná state. Samples were collected in eight localities of seven municipalities (Fig. 1): four in the eastern region (Campina Grande do Sul, Colombo, Quatro Barras, and São José dos Pinhais), one in the southwestern region (Palmas), and one in the west region (Foz do Iguaçu). Additional material collected in the neighborhoods of São Francisco and São José dos Pinhais, were also examined.

In the municipalities of Colombo (2014–2017), Coronel Vivida (2013–2014) and São José dos Pinhais (2017–2018), collections were conducted with McPhail traps. In Palmas, specimens were collected with a Malaise trap during a one-week expedition (2–6 Mar. 2015). In Campina Grande do Sul, Quatro Barras (16–21 Feb. 2015), and Foz do Iguacu (2–5 Mar. 2018), specimens were reared from fruits.

Voucher specimens are deposited in the following collections: Entomological Collection "Padre Jesus Santiago Moure", Department of Zoology, Federal University of Paraná (DZUP); Museum of Entomology Luiz de Queiroz (MELQ); Department of Entomology and Acarology, Luiz de Queiroz College of Agriculture (ESALQ); and National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM). Species identification was based mostly on Norrbom et al. (2012).

Fieldwork was supported by the project "Ampliação do conhecimento em taxonomia, sistemática e aspectos biológicos de Tephritoidea (Diptera) na Região Neotropical, em especial das famílias Tephritidae e Richardiidae", aiming to understand the diversity and distribution of the families Tephritidae and Richardiidae (Diptera) from Brazil. The sampling was supported by the National System of Biodiversity Information (SISBIO), authorization number 48020.

Geographical coordinates were obtained for each locality using a Garmin 78S GPS. The distribution data of the specimens deposited in DZUP were obtained directly from specimen labels. If unavailable directly from specimen labels, longitude and latitude were estimated using gazetteers and maps. The distribution map was made using Quantum GIS 2.8.

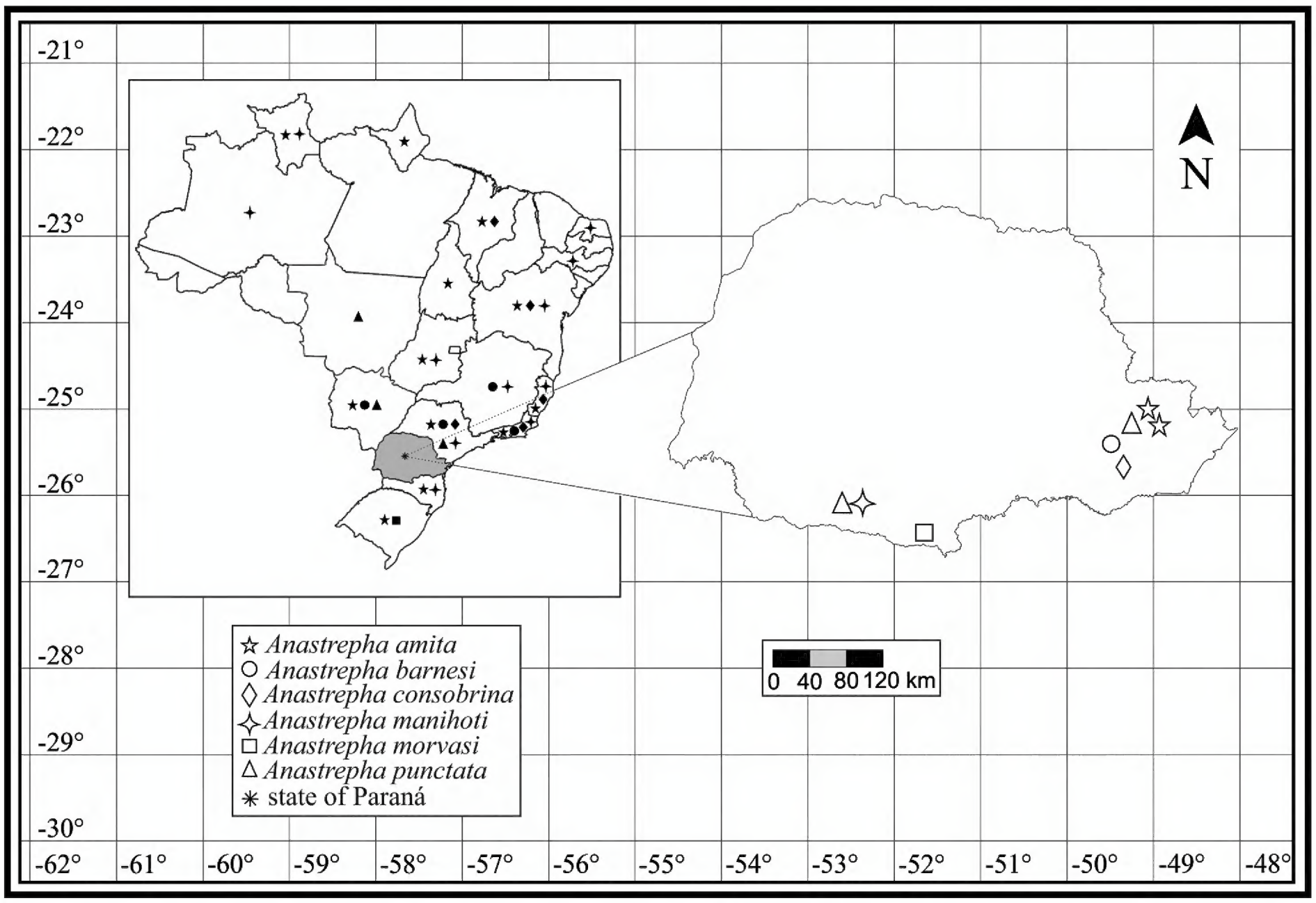

Figure 1. New records of the species of *Anastrepha* from Paraná (white symbols), and their previous occurrences (black symbols) in Brazil. (☆) *A. amita*, Campina Grande do Sul and Quatro Barras. (○) *A. barnesi*, Curitiba. (◇) *A. consobrina*, São José dos Pinhais. (✧) *A. manihoti*, Coronel Vivida. (□) *A. morvasi*, Palmas. (△) *A. punctata*, Coronel Vivida and Colombo. (✳) state of Paraná.

Results

For the first time, we present records of *Anastrepha amita* Zucchi, 1979, *A. barnesi* Aldrich, 1925, *A. consobrina* (Loew, 1873), *A. manihoti* Lima, 1934, *A. morvasi* Uramoto & Zucchi, 1999, and *A. punctata* Hendel, 1914 from Paraná state, Brazil.

Anastrepha amita Zucchi, 1979

Figure 2A

New records. BRAZIL • 9♂, 12♀; Paraná, Campina Grande do Sul, Mandaçaia road; 25°17′51″S, 049°02′12″W; alt. 920 m; 16–21 Feb. 2015; reared from fruits of *Citharexylum solanaceum* Cham.; M. Savaris, S. Lampert, A.L. Norrbom leg.; MELQ, ESALQENT00009–30. • 3♂, 4♀; Paraná, Quatro Barras, Graciosa road; 25°20′45″S, 048°58′16″W; alt. 900 m; 16–21 Feb. 2015; reared from fruits of *Citharexylum solanaceum* Cham.; M. Savaris, S. Lampert, A.L. Norrbom leg.; DZUP, USNM ENT01232112–18.

Geographic distribution. Brazil (Amapá, Bahia, Espírito Santo, Goiás, Mato Grosso do Sul, Paraná, Rio de Janeiro, Rio Grande do Sul, Roraima, Santa Catarina, São Paulo, Tocantins) (Fig. 1; Zucchi and Moraes 2008); Trinidad and Tobago (Tobago).

Identification. *Anastrepha amita* belongs to the *A. fraterculus* group, and has wing with C-band and S-band connected, narrowly along vein R_{4+5} or rarely separated, and V-band present (Fig. 2A). This species is closely related to *A. sororcula*, but it differs by the shape and length of the aculeus tip.

Anastrepha barnesi Aldrich, 1925

Figure 2B

New record. BRAZIL • 1♀; Paraná, Curitiba, São Francisco neighborhood; 25°25′17″S, 049°16′51″W; alt. 946 m; 20 Aug. 2003; G.E.G. Miranda leg.; DZUP, USNM ENT01232119.

Geographic distribution. Brazil (Mato Grosso do Sul, Minas Gerais, Paraná, Rio de Janeiro, São Paulo) (Fig. 1; Zucchi and Moraes 2008); Costa Rica (Puntarenas); Guyana; Mexico (Oaxaca); Panama (Panama); Peru (Loreto).

Identification. *Anastrepha barnesi* belongs to the *A. leptozona* group, and has wing with C-band, S-band and V-band separated (Fig. 2B). This species is close to *A. elongata* Fernández, 1953 from which it is separated by the scutum without brown vittae, the position of spiracles in the oviscape, the presence of teeth rows in the eversible membrane, and the longer aculeus tip.

Anastrepha consobrina (Loew, 1873)

Figure 2C

New record. BRAZIL • 1♀; Paraná, São José dos Pinhais, Campina do Taquaral; 25°36′07″S, 049°11′30″W; alt. 887 m; 3 Mar. 2018; McPhail trap; M. Savaris, S. Lampert leg.; MELQ, ESALQENT00031.

Geographic distribution. Brazil (Bahia, Espírito Santo, Maranhão, Pará, Paraná, Rio de Janeiro, São Paulo) (Fig. 1; Zucchi and Moraes 2008).

Identification. *Anastrepha consobrina* belongs to the *A. pseudoparallela* group, and has wing with C-band and S-band separated by hyaline band, narrowed along vein R_{4+5}, or connected, narrowly along vein R_{4+5}, and V-band complete (Fig. 2C). This species can be recognized by the long aculeus (6.2–6.7 mm) and aculeus tip serrations extending to almost the cloacal opening. *Anastrepha consobrina* is closely related to *A. amnis* Stone, 1942 but differs by having the spiracle of oviscape much farther from its base, and many more dorsobasal denticles in the eversible membrane (Norrbom 1997).

Anastrepha manihoti Lima, 1934

Figure 2D

New record. BRAZIL • 5♀; Paraná, Coronel Vivida, União do Gigante; 26°06′35″S, 052°32′02″W; alt. 606 m; 20 Mar. 2014; McPhail trap; M. Savaris, S. Lampert leg.; MELQ, ESALQENT00032–36.

Geographic distribution. Bolivia (Cochabamba, Santa Cruz); Brazil (Amazonas, Bahia, Espírito Santo, Goiás, Minas Gerais, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Roraima, Santa Catarina, São Paulo) (Fig. 1; Zucchi and Moraes 2008); Colombia (Quindío); Costa Rica (Alajuela, Cartago, Heredia, Limón, Puntarenas); Panama (Colón, Panamá); Peru (Cusco).

Identification. *Anastrepha manihoti* belongs to *A. spatulata* group, and has wing with C-band and S-band connected, broadly along vein R_{4+5}, and V-band complete, usually not connected anteriorly to S-band (Fig. 2D). This species can be identified by the triangular shape of the aculeus tip, with serrations extending beyond the cloacal opening. The shape of the aculeus tip easily separates *A. manihoti* from the other *Manihot*-infesting species.

Anastrepha morvasi Uramoto & Zucchi, 1999

Figure 2E

New record. BRAZIL • 1♂, 2♀; Paraná, Palmas, Cerro Chato farm; 26°30′09″S, 051°40′13″W; alt. 1224 m; 2–6 Mar. 2015, Malaise trap; M. Savaris, S. Lampert, A.L Norrbom leg.; MELQ, ESALQENT00047 and USNM, USNMENT895919–20.

Geographic distribution. Brazil (Paraná and Rio Grande do Sul) (Fig. 1; Zucchi and Moraes 2008).

Identification. *Anastrepha morvasi* has wing with C-band and S-band separated, and S-band and V-band connected (Fig. 2E), scutum posteriorly with pair of brown spots, short aculeus (0.7–0.9 mm), and aculeus tip with minute serration. *Anastrepha morvasi* is readily distinguished from species of the *A. punctata* group by its short aculeus.

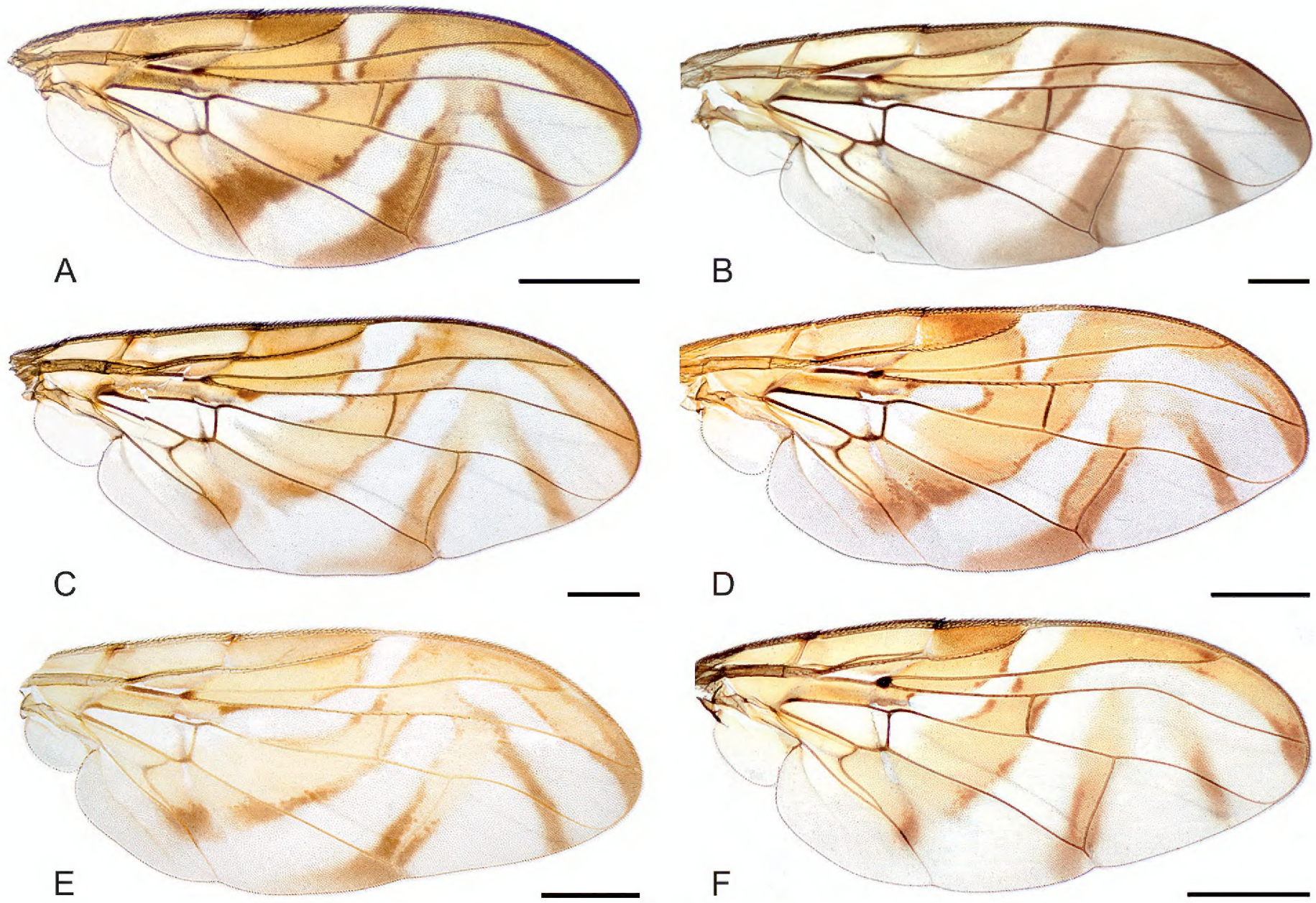

Figure 2. Wing patterns of new records of species of *Anastrepha* from Paraná. **A.** *Anastrepha amita*. **B.** *A. barnesi*. **C.** *A. consobrina*. **D.** *A. manihoti*. **E.** *A. morvasi*. **F.** *A. punctata*. Scale bars:1 mm.

***Anastrepha punctata* Hendel, 1914**
Figure 2F

New records. BRAZIL: • 5♂, 7♀; Paraná, Colombo, Canguiri neighborhood; 25°22′45″S, 049°07′54″W; alt. 910 m; Jan.–Feb. 2017; McPhail trap; M. Savaris, S. Lampert leg.; MELQ, ESALQENT00037–42 and DZUP, USNMENT01232120–24. • 4♀; Paraná, Coronel Vivida, União do Gigante; 26°06′35″S, 52°32′02″W; alt. 606 m; 12 Jan. 2014; M. Savaris, S. Lampert leg.; MELQ, ESALQENT00043–46.

Geographic distribution. Argentina (Tucumán); Bolivia (Chuquisaca); Brazil (Mato Grosso, Mato Grosso do Sul, Paraná, São Paulo) (Fig. 1; Zucchi and Moraes 2008); Paraguay (Cordillera).

Identification. *Anastrepha punctata* belongs to the *A. punctata* group. This species has wing with C-band and S-band separated, and V-band distal arm complete, isolated, usually not connected to proximal arm of V-band or to S-band (Fig. 2F). It differs from *A. morvasi* by the aculeus longer (1.25–1.7 mm) with tip not serrate.

Discussion

The first records of *Anastrepha* species from Paraná were obtained by Fehn (1981). Until the beginning of 2000s, nine species of *Anastrepha* were recorded in the state (Garcia 2003). Recently, Monteiro et al. (2019) recorded the occurrence of more four species (*A. daciformis*, *A. dissimilis*, *A. distincta* and *A. pickeli*), without associating them with hosts. In this work, we reared *A. distincta* from fruits of *Inga laurina* (Sw.) Willd., and *Inga vera* Willd. (first record), collected between 2–5 March 2018 in Foz do Iguaçu, Paraná. We also report six new records of *Anastrepha* species from Paraná and increase the number of species from 15 to 21. In addition, we report for the first time *Citharexylum solanaceum* Cham. (Verbenaceae) as host plant for *A. amita*.

Anastrepha amita was recorded from two municipalities, Campina Grande do Sul and Quatro Barras (Fig. 1), reared from fruits of *C. solanaceum*, which is a new host record for *A. amita*. It was also reared in *C. solanaceum* in Santa Catarina (first record) (Parque Nacional Aparados da Serra, Rio do Boi trail; 29.20473°S, 50.05302°W; alt. 331 m, emerged on 27–31 Mar 2015; reared from fruit collected on 7 Mar 2015; M. Savaris and A. L. Norrbom leg.; MELQ, ESALQENT00048–55). This fly was previously registered from *Citharexylum myrianthum* Cham., in the state of São Paulo (Souza-Filho et al. 1999); *C. poeppigii* Walp., in Amajari, state of Roraima (Marsaro Júnior et al. 2010); and from *Duranta erecta* L. (Verbenaceae), *Gmelina arborea* Roxb., and *Vitex megapotamica* (Spreng.) Moldenke (Lamiaceae) in the state of São Paulo (Custódio et al. 2016). Considering the new record for this species from Paraná, *A. amita* is now known to

occur in 13 Brazilian states (Fig. 1).

We report the occurrence of *A. barnesi* for Curitiba (Fig. 1), based on a single female collected in the window of an apartment (first floor), in the São Francisco neighborhood. This fly is rarely collected in Brazil but was previously recorded from the states of Minas Gerais, Mato Grosso do Sul, Rio de Janeiro, and São Paulo (Zucchi and Moraes 2008).

A female of *A. consobrina* was collected with a McPhail trap at the Campina do Taquaral in São José dos Pinhais. The trap was hung at 16 m high, in the crown of a guabiroba tree (*Campomanesia reitziana* D. Legrand), in an area of Mixed Ombrophilous Forest. The trap height in the canopy may have influenced the collection of this Fruit Fly, which is not found frequently. *Anastrepha consobrina* has been reported from the states of Bahia, Espírito Santo, Maranhão, Pará, Rio de Janeiro and São Paulo (Zucchi and Moraes 2008) (Fig. 1).

The specimens of *A. manihoti* were collected in McPhail traps in the União do Gigante, in the interior of Coronel Vivida municipality (Fig. 1). This fly was recorded on *Manihot esculenta* Crantz (Euphorbiaceae) (Lima 1934), attacking and damaging the developing branches. Cassava is the only known host for *A. manihoti*, which is widely distributed in Brazil. Previously, *A. manihoti* was recorded in 11 Brazilian states (Zucchi and Moraes 2008).

In Palmas, we collected three specimens (1 male and 2 females) of *A. morvasi* with a six-meter Malaise trap. The specimens were collected in a transition area of Mixed Ombrophilous Forest at an altitude of 1,224 meters, near the border of the Chupim River (Fig. 1). This fly was registered only from the type locality, Vacaria, Rio Grande do Sul (Uramoto and Zucchi 1999). This second record of *A. morvasi* suggests that this fly is distributed in highland areas of the southern states of Brazil.

The specimens of *A. punctata* were found in Colombo and Coronel Vivida. In Colombo, the specimens were collected in January and February of 2017, in McPhail traps with hydrolyzed protein that were installed on the border of a small area of Mixed Ombrophilous Forest in the Canguiri neighborhood. In Coronel Vivida, the specimens were collected with McPhail traps, which were installed on the border of Mixed Ombrophilous Forest, near crops areas and in a citrus orchard, in the União do Gigante. Within Brazil, this species is registered for the states of Mato Grosso, Mato Grosso do Sul and São Paulo (Zucchi and Moraes 2008) (Fig. 1). This fly was recorded on *Psidium guajava* L. (Blanchard 1937; Malavasi et al. 1980).

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Authors' Contributions

MS, ALN and SL collected the specimens in the field; ALN and MS identified the specimens; MS and SL made the distribution map. MS, SL and RAZ conceived the study and analyzed the data. All authors wrote the final version of manuscript.

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